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(54) **Process and machine for parting the cap of connecting rods, particularly connecting rods for internal-combustion engines**

(57) According to the invention, parting of the cap (12) of the connecting rod (11) is achieved by engaging the eye of the big end of the connecting rod with two semi-cylindrical fixtures, respectively a fixed fixture (15) and a movable fixture (17), which are actuated by a hydraulic actuator (24) which is interposed between them and is adapted to expand the fixtures in a diametrical direction against the inner surface of the eye of the big end of the connecting rod, subjecting the piston (25) of the actuator

(24) to the action of a hydraulic fluid fed into the respective actuation cylinder (26) at an optional pre-loading pressure that is in any case lower than the pressure required to reach the yield point of the material of the connecting rod, and producing an instantaneous peak in the pressure of the fluid fed to the hydraulic actuator (24) by means of an auxiliary piston (35) that is subjected to the momentary action of a striking mass (42).

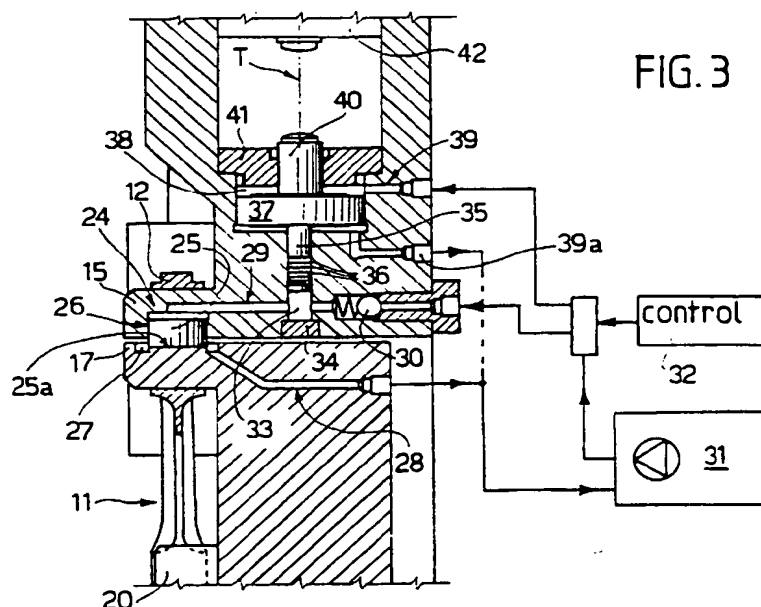


FIG. 3

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## Description

The present invention relates to a process and a machine for parting the cap of connecting rods, particularly connecting rods for internal-combustion engines.

It is known that connecting rods for internal-combustion engines comprise an elongated portion, or shank; one end is the so-called small end, which is the end of the connecting rod that is connected to the pivot and actuated with a straight-line motion, and the other end is the so-called big end, which is the end of the connecting rod that rotates. Due to assembly requirements, the big end of the connecting rod has a detachable portion, known as cap, which is connected to the other big end portion by means of two or more bolts.

In the past, the cap of the big end of the connecting rod was formed by cutting said big end diametrically; this method required subsequent accurate machining to flatten and grind the cutting surfaces in order to ensure perfect mating of the cap with the remaining portion of the big end, which is an indispensable condition for keeping the stresses on the connecting bolts within safety limits.

The cap is currently separated from the big end by controlled parting, which is started from diametrically opposite grooves formed during casting or by mechanical machining on the internal cylindrical surface of the eye of the big end of the connecting rod which couples to the crankshaft.

In this manner, the parting surfaces allow subsequent perfect connection of the cap to the big end of the connecting rod, the consequent elimination of flexural and/or shearing stresses on the connecting bolts, and a significant simplification in the production cycle in general. The methods for parting the cap are essentially based on the concept of applying an axial expansion force to the internal cylindrical surface of the eye of the big end of the connecting rod by means of a diametrically expandable fixture that is capable of transmitting to said surface a parting force the resultant whereof is directed along the axis of symmetry of the connecting rod.

Known procedures for transmitting said parting force are essentially mechanical or hydraulic. A typical mechanically-acting parting procedure, albeit limited to connecting rods produced with pulverised metal forging methods, is disclosed in European patent no. 0 396 797, of May 10, 1989. According to this known procedure, the internal surface of the eye of the big end of the connecting rod is engaged by two oppositely arranged semicylindrical fixtures which are rigidly coupled respectively to a fixed support, to which the connecting rod is also rigidly coupled, and to a sliding support, which receives the impact of a striking mass and transmits it to the internal surface of the eye of the big end of the connecting rod, causing parting of the cap.

The condition for correctly parting the cap with such procedures is that the blow transmitted by the striking mass must act so that it is exactly centered on the axis of symmetry of the connecting rod. This entails a highly accurate execution of the machine, an equally accurate

positioning of the connecting rod being machined on the fixed support, and a complicated retention system that is adapted to prevent even small rotations of the shank of the connecting rods during the execution of the parting procedure; all these requirements negatively affect the manufacturing and running costs of the machine and keep the efficiency of this known procedure at low levels in terms of parts machined per unit time.

Furthermore, in view of the intensity of the forces involved, this known procedure entails considerable and quick wear of the contact surfaces of the machine parts that are subjected to the parting force, consequently causing loss of the co-planarity of said surfaces and therefore of the indispensable centering of the action of the striking mass with respect to the axis of symmetry of the connecting rods.

Hydraulic-type procedures avoid these drawbacks but do not yield satisfactory results as regards the parting method as to the microcrystalline structure of the parting surfaces.

A typical hydraulic parting procedure is disclosed in US patent no. 4,754,906, of March 11, 1987. According to this known procedure, too, the internal surface of the eye of the big end of the connecting rod is engaged by two oppositely arranged semicylindrical fixtures, respectively a fixed one and a movable one, between which the piston of a hydraulic cylinder is interposed; said hydraulic cylinder is adapted to expand the fixtures in a diametrical direction, and a pressure multiplier feeds hydraulic fluid to said cylinder.

The greatest drawback of this known hydraulic parting method is the relatively slow rate at which the pressure of the hydraulic fluid fed into said hydraulic cylinder reaches the value required to part the cap. The material of the cap thus undergoes yielding and elongation, which negatively affect, as mentioned above, both the microcrystalline structure of the parting sections and the geometry of the connecting rod being machined, causing problems in the subsequent assembly of said cap.

The aim of the present invention is to start from the notion of the above drawbacks of known hydraulic and mechanical parting machines and procedures and eliminate them.

In particular, an important object of the invention is to combine the advantages of mechanical and hydraulic parting procedures, eliminating their respective drawbacks.

In particular, another object of the invention is to provide a parting machine and procedure that on one hand eliminate the requirement, typical of known mechanically-acting machines, of perfectly centering the striking mass with respect to the axis of symmetry of the connecting rod being machined, and on the other hand eliminate the yielding and elongation of the material of the connecting rod that characterize parting procedures performed with known hydraulically-operated machines.

A further important and particular object of the invention is to provide a procedure and a machine for parting the cap of the big end of the connecting rod which

are extremely simplified and are capable of ensuring high efficiencies in terms of parts machined per unit time and of reducing machining rejects to negligible values.

Another object of the invention is to provide a parting machine for the specified use that is very compact but highly efficient and reliable in operation and is particularly adapted for being installed in integrated and automated systems for mass-producing connecting rods for motor vehicle engines and the like.

According to the present invention, this aim, these important objects, and others are achieved by providing a procedure and a machine for parting the cap of the big end of connecting rods having the specific characteristics stated in the appended claims.

Substantially, the invention is based on the concept of using a mixed hydraulic and mechanical procedure which consists in engaging the eye of the big end of the connecting rod with two semicylindrical fixtures, respectively a fixed one and a movable one, which are actuated by a hydraulic actuator which is interposed between them and adapted to expand said fixtures in a diametrical direction; in subjecting the piston of the actuator to the action of a hydraulic fluid fed into the respective actuator cylinder at a pre-loading pressure that is lower than the one required to reach the yield point of the material of the connecting rod; and in producing an instantaneous peak in the pressure of the fluid fed to the hydraulic actuator by means of an auxiliary pressure-multiplying piston that is subjected to the momentary action of a striking mass.

The machine that performs the process according to the invention essentially comprises a first fixed semicylindrical fixture, which is supported by a corresponding fixed support that is rigidly coupled to the frame of the machine, which is preferably arranged vertically, and a second movable semicylindrical fixture, which is supported by a corresponding movable support that receives and retains the shank and the small end of the connecting rod being machined by means of adapted retention devices and is slideable on vertical guides of said frame. The hydraulic actuator is interposed between the two fixtures and comprises an expansion piston, which is slideable hermetically within a seat of a hydraulic cylinder formed in the body of the fixed fixture and has an active pusher surface that engages, by front surface contact, a corresponding contrast surface of the movable fixture.

A stream of hydraulic fluid at moderate pressure (clamping pressure) is fed into said cylinder seat of the hydraulic actuator by means of a respective feed duct and through a check valve. The feed duct is crossed by a blind cavity into which the rod of a multiplier piston slides hermetically; said piston is hermetically slideable in a corresponding multiplier cylinder and supplies said pre-loading pressure to the hydraulic actuator. A second rod of the piston of said multiplier preferably protrudes out of the respective multiplier cylinder along the axial path of a striking mass which acts on the multiplier piston so as to produce, by means of the penetrating rod of said

multiplier, a corresponding pressure peak in the cylinder of the hydraulic actuator and the consequent parting of the cap of the big end of the connecting rod.

The striking mass is preferably subjected to an acceleration means, which can also be used as an element for resetting said mass.

Further characteristics, purposes, and advantages of the machine and of the process according to the present invention will become apparent from the following detailed description and with reference to the accompanying drawings, given by way of non-limitative example, wherein:

figure 1 is a schematic front elevation view of the machine according to the invention in a preferred embodiment;

figure 2 is a sectional view, taken along the multiple planes II-II of figure 1;

figure 3 is an enlarged-scale sectional view, of the detail III of figure 1;

figure 4 is a plot of the pressure of the fluid at each individual parting cycle.

In the drawings, the reference numeral 10 generally designates the machine, and the reference numeral 11 designates the connecting rod of an internal-combustion engine which comprises a shank 11a, a big end 11b, from which the cap 12 must be broken off, and a small end 11c.

The machine 10 comprises a fixed frame 14, which is preferably vertical and acts as a rigid and fixed support for a corresponding fixed semicylindrical fixture 15, and a movable support 16 for a corresponding movable semicylindrical fixture 17; the fixtures 15-17 are juxtaposed at the respective diametrical parting planes, and the movable support is slideable along vertical guides 18, of the type with rollers, which are supported by the frame 14.

A fluid-driven actuator, preferably a hydraulic actuator 19, is provided at the base of the frame 14 to raise the support 16 and place the movable fixture adjacent to the fixed fixture, in order to insert both fixtures in the eye of the big end of the connecting rod 11b when said connecting rod is arranged in the working position on the machine 10.

As clearly shown in figures 1 and 2, in this working position the shank 11a of the connecting rod 11 lies parallel to the movable support 16 on which there is a first retention device for the small end 11c of the connecting rod, which is constituted for example by lateral supports 20, and there is a second retention device 21 for immobilizing the big end 11b of the connecting rod. A third retention device 22 for immobilizing the big end of the connecting rod is also provided on the fixed frame 14 that constitutes the support of the fixed fixture 15. The retention devices 21 and 22 may be of various kinds, for example constituted by plates 23 provided with clamping pins (not shown) of the threaded type, or clamping rods con-

trolled by actuators, which act along respective retention axes shown in the figure.

A fluid-driven actuator, preferably a hydraulic actuator, generally designated by the reference numeral 24 (figure 3), is interposed between the fixed fixture 15 and the movable fixture 17 and is adapted to cause the expansion of said fixtures in a diametrical direction against the inner surface of the eye of the big end 11b of the connecting rod to transmit to said surface a force whose resultant, directed along the axis of symmetry of the connecting rod 11, parts the cap 12.

In a per se known manner, parting occurs along a parting plane that passes through diametrically opposite initiation grooves provided on the inner surface of the eye of the big end 11b and not shown in the figure. The actuator 24 comprises an expansion piston 25, which is hermetically slideable within a hydraulic cylinder seat 26 formed in the body of the fixed fixture 15 and has an active pusher surface 25a that engages, by front surface contact, a corresponding contrast surface of the movable fixture 17. Said contrast surface is preferably recessed with respect to the diametrical parting plane of the fixture 17 and is surrounded by a hydraulic fluid collection channel 27 which is connected to a drain duct 28 adapted to recover any fluid that may have seeped through the coupling between the piston 25 and the cylinder 26. A stream of hydraulic fluid at moderate pressure which originates from a source of fluid 31 that cooperates with a control element 32 is fed into the cylinder 26 of the actuator by means of a respective feed duct 29 and a check valve 30; said moderate pressure, referenced by P1 in figure 4 and termed "clamping pressure", is comprised for example between 20 and 60 bar.

As clearly shown in figure 3, the feed duct 29 is crossed by a blind cylindrical cavity 33 which is closed by a plug 34. The rod 35 of a multiplier piston 37 enters the cylindrical cavity 33 and is provided with hydraulic sealing means 36; said piston 37 is hermetically slideable within a corresponding multiplier cylinder 38, and the ratio between the diameter of the penetrating rod 35 and the diameter of the multiplier piston 37 is between 1/10 and 1/25. The hydraulic fluid from the source 31 is also fed into the multiplier cylinder 38 by means of a corresponding duct 39, so that the penetrating rod 35, by virtue of the thrust of the multiplier piston 37 and of the presence of the check valve 30 that closes the feed duct 29, raises the pressure of the fluid in the cylinder of the actuator 24 to a pre-loading value P2 (figure 4) which produces a force on the piston 25 of the actuator 24 that is in any case lower than the yield point of the metal of the connecting rod 11.

A drain duct 39a is provided on the cylinder 38 to recover any fluid that may have seeped through the coupling between the piston 37 and the cylinder 38. According to the invention, the multiplier piston 37 is furthermore provided with a second rod 40 which hermetically passes through a lid 41 of the multiplier cylinder 38 and protrudes outside said cylinder along the path T along which a striking mass 42 moves axially; said mass is movable along

vertical guides of the frame 14 and acts on the penetrating rod 35 by means of the multiplier piston, so as to produce a corresponding momentary pressure peak P3 (figure 4) in the cylinder of the actuator 24.

Accordingly, the piston 25 of the actuator 24 discharges a momentary force onto the fixtures 15 and 17; said force is capable of instantaneously parting the cap 12. The momentary nature of the action of the piston 24 on the fixtures 15-17, generated by the impact of the striking mass 42, is such as to avoid the yielding and elongation of the material of the connecting rod 11, and produces parting sections that are particularly adapted for the subsequent connection of the cap 12 to the big end of the connecting rod 11.

Preferably, the striking mass 42 is controlled by an accelerator element 43 which is constituted for example by a hydraulic jack that includes an acceleration spring 44 which can also be used to reset the striking mass 42.

Of course, without altering the concept of the invention, the details of the execution of the process and the embodiments of the machine that performs said process may be altered extensively with respect to what has been described and illustrated by way of non-limitative example without thereby abandoning the scope of the invention as defined by the appended claims, wherein the reference numerals are included merely for the sake of better comprehension.

## Claims

1. Process for parting the cap (12) of connecting rods (11) particularly for internal-combustion engines, characterized in that it comprises the following operating steps:

- a) engaging the eye of the big end (11a) of the connecting rod with two semicylindrical fixtures, respectively a fixed one (15) and a movable one (17), which are controlled by the action of a hydraulic actuator (24) that is interposed between them and is adapted to cause the expansion of said fixtures in a diametrical direction against the internal surface of the eye of the big end (11b) of the connecting rod;
- b) subjecting the piston (25) of the actuator (24) to the action of a hydraulic fluid which is fed into the respective actuation cylinder (26) to an optional pre-loading pressure (P2) which is in any case lower than the pressure required to reach the yield point of the material of the connecting rod (11);
- c) producing an instantaneous peak (P3) in the pressure of the fluid fed into the hydraulic actuator (24) by means of an auxiliary piston (35-37-42) which is subjected to the momentary action of a striking mass (42).

2. Process according to claim 1, wherein the pre-loading step (P2) is preceded by a clamping step per-

formed by feeding a stream of hydraulic fluid to the hydraulic actuator (24) at a corresponding moderate clamping pressure (P1).

3. Process according to claims 1 and 2, wherein the stream of fluid that generates the clamping pressure (P1) is fed unidirectionally to said hydraulic actuator (24).
4. Process according to the preceding claims, wherein the pre-loading pressure (P2) and the instantaneous pressure peak (P3) that parts the cap (12) of the connecting rod are generated, by means of the auxiliary piston, in the fluid stream fed to the hydraulic actuator (24) downstream of a check valve (30) of the duct that supplies said stream.
5. Machine for performing the process according to claims 1 to 4, characterized in that it comprises: a fixed frame (14) which acts as a rigid and fixed support for a corresponding fixed semicylindrical fixture (15); a movable support (16) for a corresponding movable semicylindrical fixture (17), said support being slideable along guides of said frame (14), said fixed and movable fixtures (15, 17) being juxtaposable at the respective diametrical parting planes to engage the eye of the big end (11b) of the connecting rod (11); a hydraulic actuator (24) which is interposed between said semicylindrical fixtures and is adapted to cause their diametrical expansion in the direction of the axis of the shank (11a) of the connecting rod (11); means (29-30-31) for unidirectionally feeding a stream of hydraulic fluid at moderate pressure to the hydraulic actuator (24) which is interposed between said fixtures; and pressure generating means (35-37-40) that are subjected to the action of a striking mass (42) adapted to produce a momentary pressure peak in said hydraulic actuator (24) and the consequent parting of the cap (12) of the connecting rod (11).
6. Machine according to claim 5, characterized in that the fixed and rigid frame (14) of the machine is of the vertical type and the support (16) of the movable semicylindrical fixture (17) is slideable on vertical roller guides supported by said frame.
7. Machine according to claims 5 and 6, characterized in that the movable support (16) is controlled by an actuation means (19) adapted to raise said support to allow the fixed and movable fixtures (15, 17) to be mutually adjacent and to allow the insertion of both fixtures in the eye of the big end (11b) of the connecting rod when said connecting rod is arranged on the machine (10) in working position.
8. Machine according to claims 5 to 7, characterized in that said fixed frame (14) and said movable support (16) comprise retention means (20-21-22) for lock-

ing the big end (11b) and the small end (11c) of the connecting rod (11) in working position.

9. Machine according to claims 5 to 8, characterized in that the hydraulic actuator (24) interposed between the fixed and movable semicylindrical fixtures (15-17) comprises an expansion piston (25) that is hermetically slideable within a hydraulic cylinder seat (26) formed in the body of the fixed fixture (15), and in that the expansion piston (25) has an active pusher surface (25a) that engages, by front surface contact, a corresponding contrast surface of the movable fixture (17).
10. Machine according to claim 9, characterized in that said contrast surface of the movable fixture (17) is surrounded by a collection channel (27) for the seeped hydraulic fluid which is connected to a duct (28) for draining and recycling said seeped fluid.
11. Machine according to claim 5 and any one of claims 6 to 10, characterized in that it comprises a feed duct (29) which is provided with a check valve (30) for feeding to the hydraulic actuator (24) a stream of hydraulic fluid which is supplied by a source of fluid (31) at a moderate pressure between 20 and 60 bar.
12. Machine according to claims 5 and 11, characterized in that said feed duct (29) is crossed by a blind cylindrical cavity (33) in which the rod (35) of a multiplier piston (37) penetrates hermetically, said piston being hermetically slideable within a corresponding multiplier cylinder (38); and in that said penetrating rod is adapted to produce, by virtue of the closing of the feed duct (29) by the check valve (30), increases in the pressure of the fluid fed into the actuator that correspond to the hydraulic and/or mechanical stresses applied to the multiplier piston (37) and respectively transmitted through the rod (35) of said piston.
13. Machine according to claims 5 and 12, characterized in that said multiplier piston (37) comprises a second rod (40) which protrudes outside the multiplier cylinder (38) along the axial path of the motion of the striking mass (42); said striking mass being movable along vertical guides of the frame (14) of the machine and being subjected to an accelerator element which is provided with integrated means for resetting said mass.

FIG.1

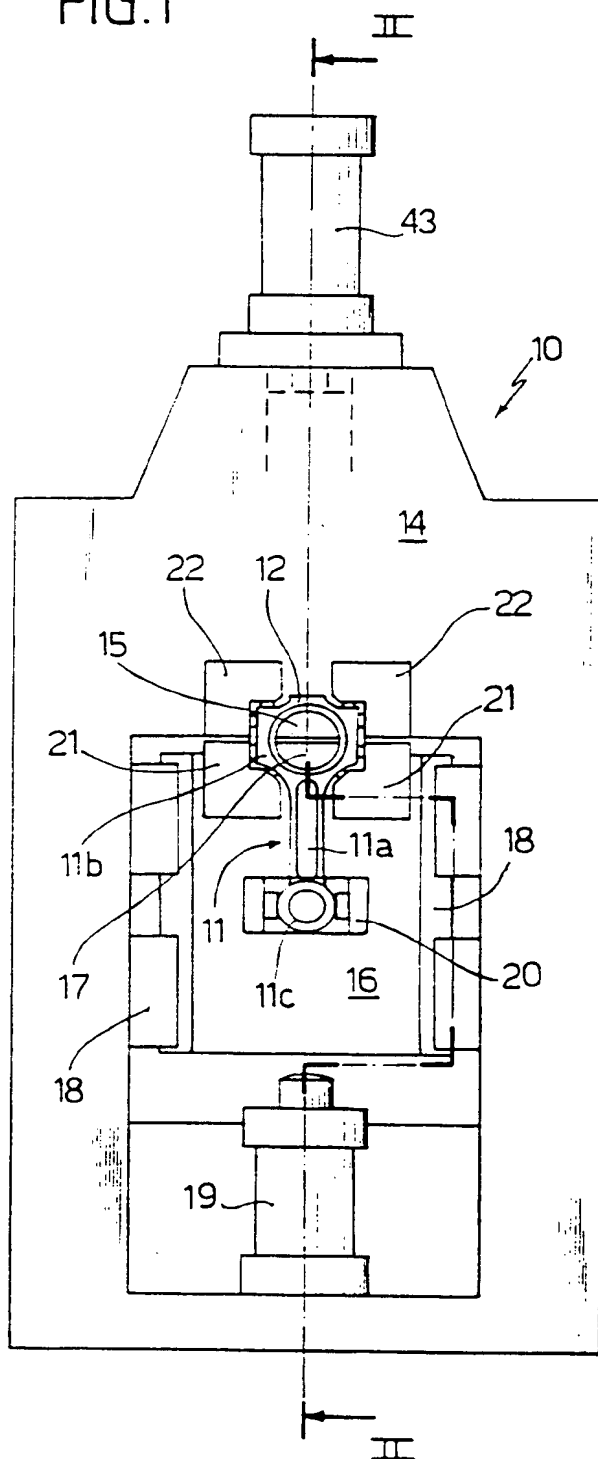
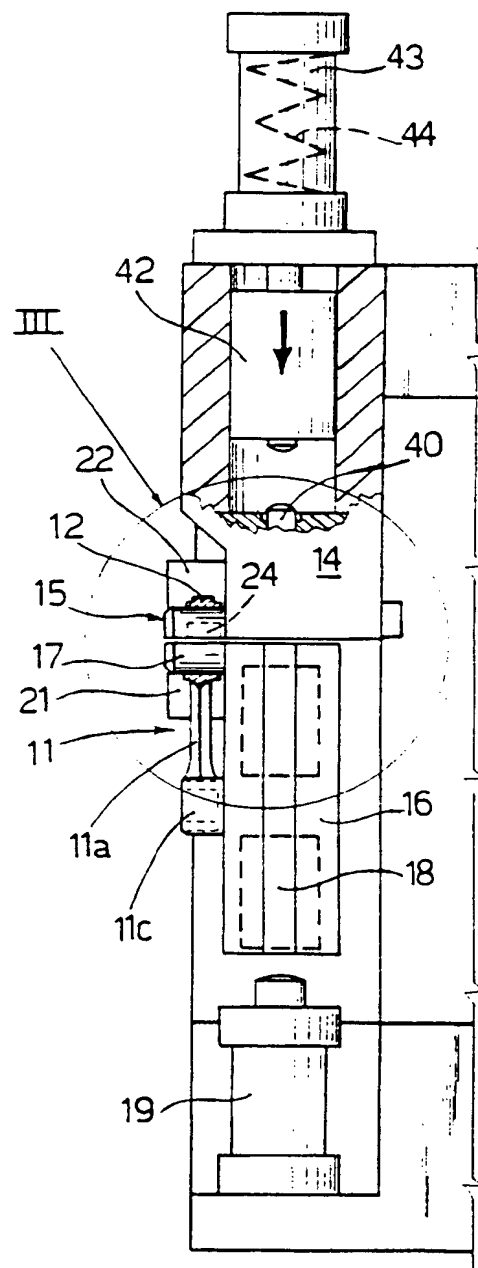


FIG. 2



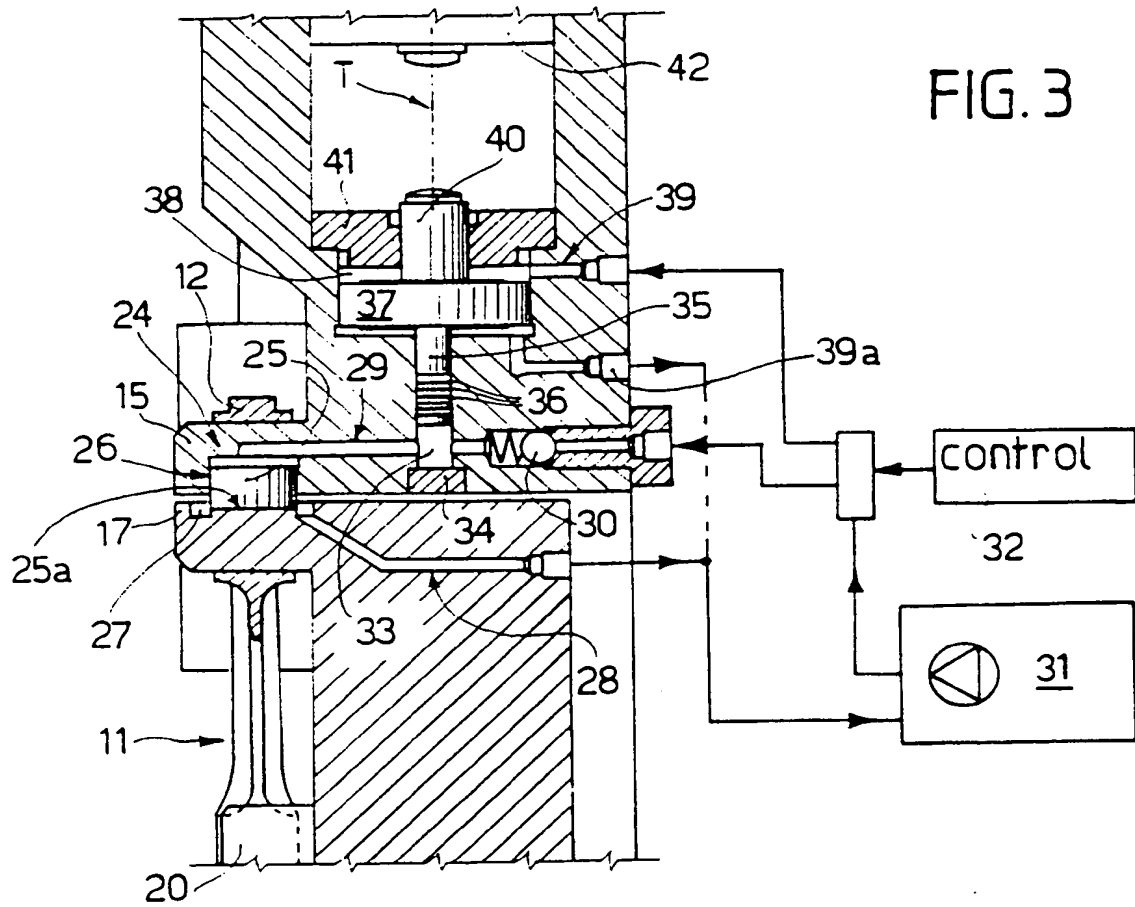
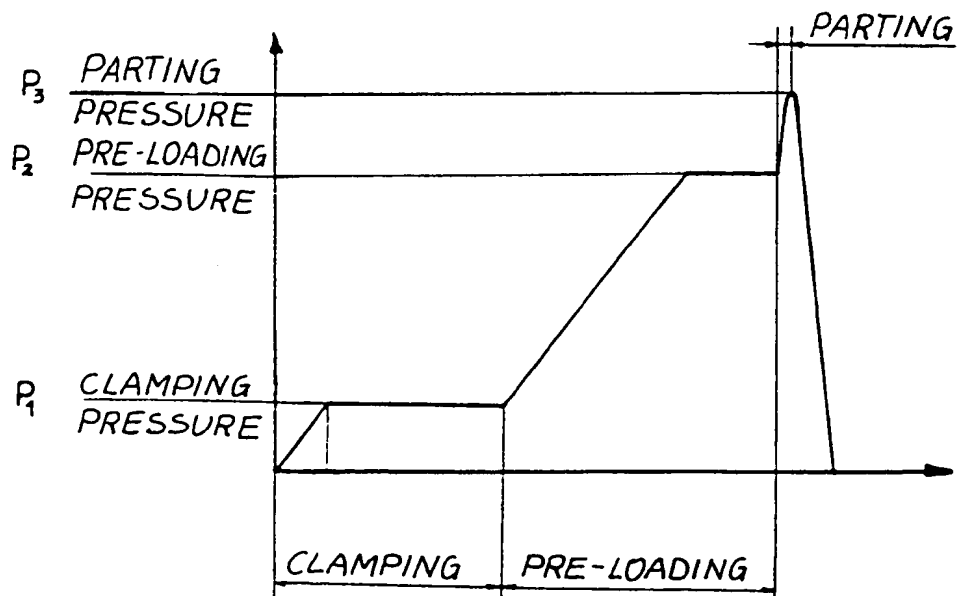


FIG. 4





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# EUROPEAN SEARCH REPORT

Application Number  
EP 95 11 6278

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
D,A	US-A-4 754 906 (BROVOLD) the whole document	1	B23D31/00
A	EP-A-0 396 797 (MIESSEN)		
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)
			B23D F15B
The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 9 February 1996	Examiner Berghmans, H
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FIG.1

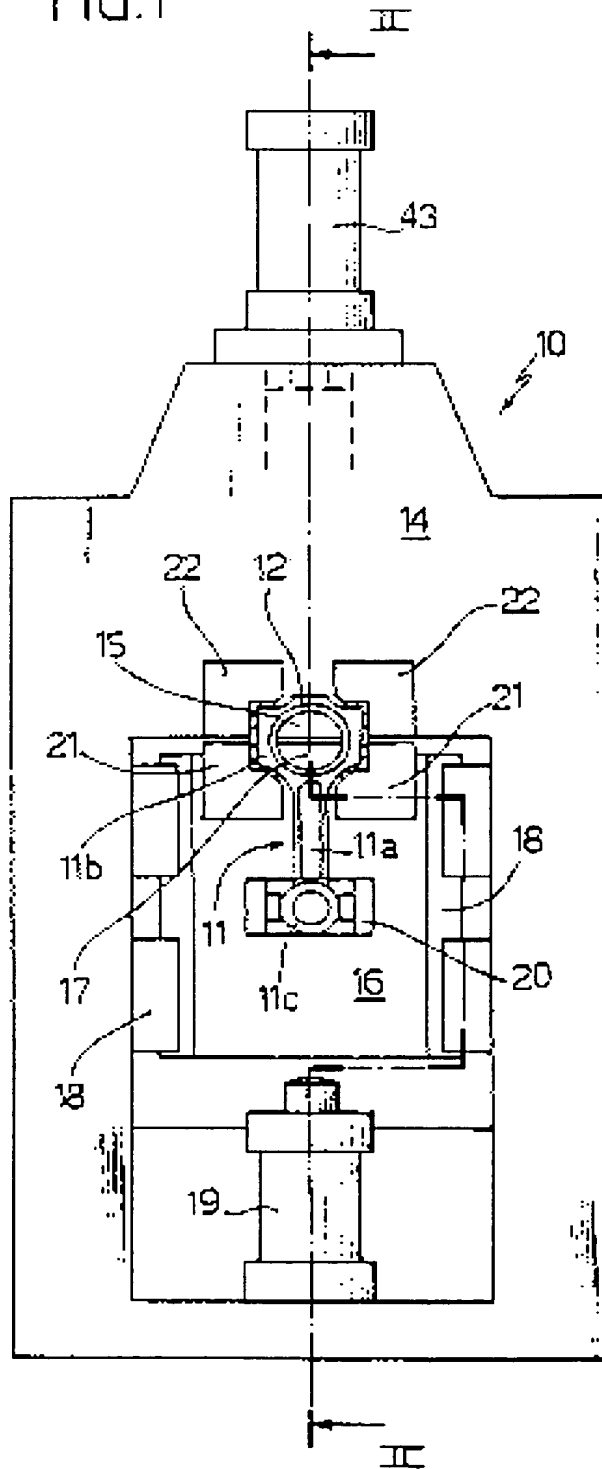
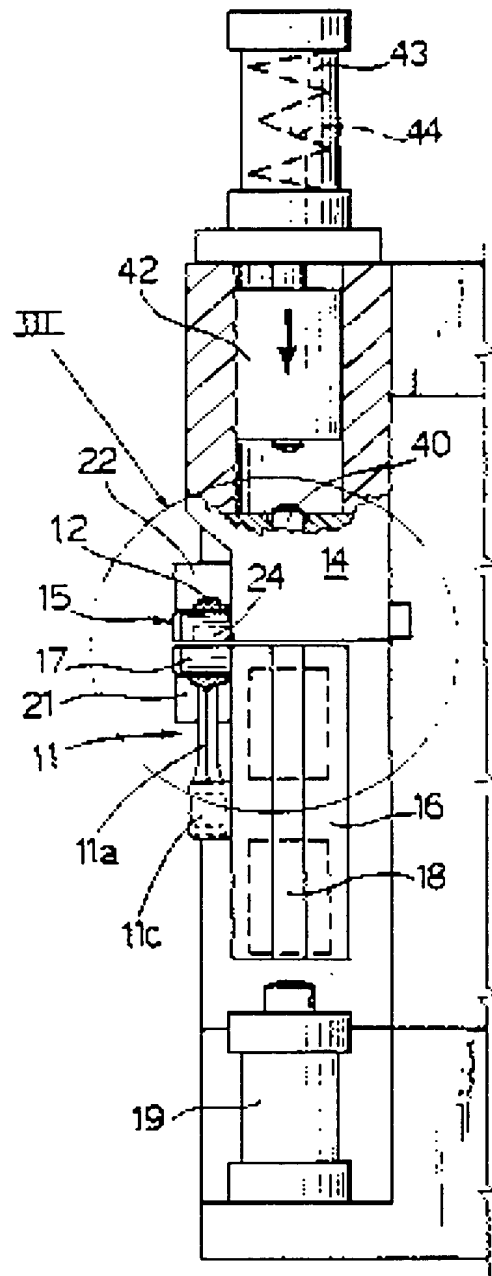


FIG.2



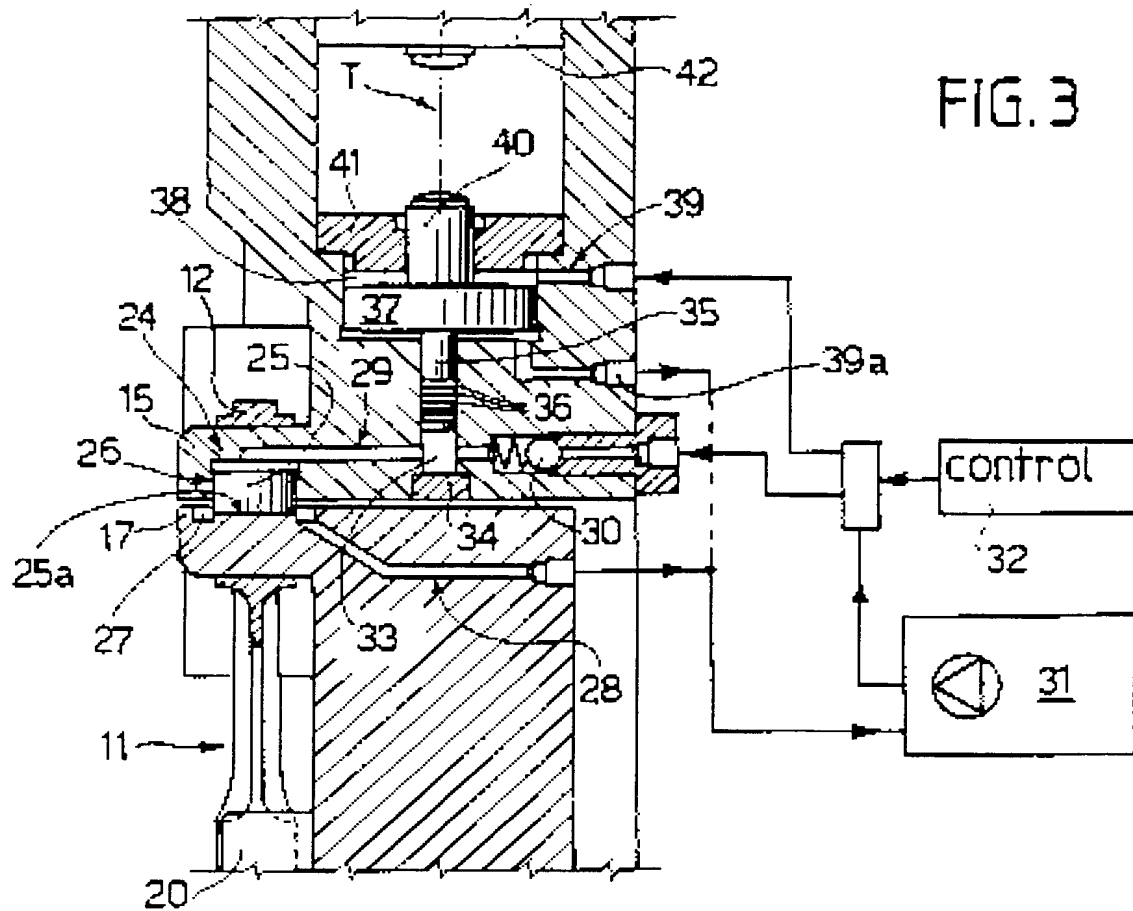


FIG. 4

